Method for Manufacturing Liquid Crystal Display Device

FIELD OF THE INVENTION

A method for manufacturing liquid crystal display device featured with reduced thickness and weight of the device. In particularly, the present invention relates to a method for manufacturing liquid crystal display device applicable to a flexible plastic substrate, which has increased yields and diversified display modes.

BACKGROUND OF THE INVENTION

Reduced weight and volume is a main focus in the development of flat panel display technology. Effort is made to device a new flat panel display, which is light, compact, shock resistant and low power consumption in the flat panel display industry. For realizing such a flat panel display, which is light, slim and shock resistant, research focus of flat panel display technology has shifted from prior art glass substrate based process into plastic substrate based process. A patent application filed to WIPO No. WO02/42832A2 by KONINKL PHILIPS ELECTRONICS NV comprises technology based on the new plastic substrate display manufacturing process, wherein the technology involves with wrapping liquid crystal with polymeric material on the substrate. Steps of the process comprised in the patent application are shown

in FIG. 1A to FIG. 1E. Firstly, in FIG. 1A, a layer of photopolymer material mixture 2 is coated on a substrate 1. The photopolymer material mixture 2 is composed of NOA 65 and liquid crystal materials. In FIG. 1B, a blade 3 is utilized for leveling the photopolymer material mixture 2. In FIG. 1C, the photopolymer material mixture 2 is positioned under a mask 4, and exposed under ultra violate 5 for an exposure process step. The area of the photopolymer material mixture 2 exposed under the ultra violate 5 is hardened and forms a plurality of polymer wall columns 20 as shown in FIG. 1D. A second exposure process step is performed as showed in FIG. 1E. However, the strength of the ultra violate 6 is weaker and exposure time is longer than the first exposure. The second exposure forms a thin hardened layer 21 on the surface of the photopolymer material mixture 2. Then the process moves to the step of completing phase separation between liquid crystal and the photopolymer material.

The patent application filed by KONINKL PHILIPS ELECTRONICS NV requires two exposures for forming a polymer structure wrapping liquid crystal in the manufacturing process. In addition, the second exposure involves with a step using low energy and long process time, which may cause deterioration of liquid crystal. Also, the manufacturing window is small, the yield rate is slow, and the display modes applicable are limited. Further

more, in the patent application No. WO02/42832A2 by KONINKL PHILIPS ELECTRONICS NV, the method used in forming polymer walls adapts a phase separation technique, which leads to a increased amount of polymer and interfere with the quality of liquid crystal formation. The present invention utilizes a mask exposure or molding method for forming polymer wall. Such technique involves with reduced amount of polymer used also results in increased quality of liquid crystal formation.

For resolve the aforementioned problems, a method for manufacturing liquid crystal display device is provided in the present invention, which offers increased yield rate and display modes.

SUMMARY OF THE INVENTION

A method for manufacturing liquid crystal display device is disclosed in the present invention. The main features are described in the following. A first photopolymer layer is coated on the support substrate and a substrate having a buffer layer is treated by photopolymerization. A substrate is treated by processes for forming a conducting layer, an alignment layer and projections as required by general LCD manufacturing. A second photopolymer layer is coated on the substrate having a plurality of pixel electrodes, an alignment layer, and projections as required by general LCD manufacturing. Mask exposure is applied to the

substrate and the photopolymer forms a polymer wall. Alternatively molding can be applied to the substrate along with linear ultra violet exposure. The photopolymer layer is hardened by such process and forms a polymer wall with alignment. The cavities in the polymer wall are filled with mixture of liquid crystal and small amount of photopolymer. The support substrate and the substrate are aligned and treated by mask exposure for coupling the support substrate to the substrate via photopolymerization. The support substrate is separated from the substrate and accordingly a single substrate LCD device is generated. The same method can be applied to manufacturing process for a LCD device without a substrate. The method increases yield rate also provides a different method for manufacturing a LCD device.

The invention can be more fully understood by reading the following detailed description of the preferred embodiments, with reference made to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A to 1E are schematic diagrams illustrating manufacturing process of a single substrate liquid crystal display device in the prior art;

FIG. 2A to FIG. 2N are schematic diagrams illustrating manufacturing process of a single substrate liquid crystal display

device in the first embodiment according to the present invention;

FIG. 3A to FIG. 3N are schematic diagrams illustrating manufacturing process of a single substrate liquid crystal display device in the second embodiment according to the present invention;

FIG. 4A to FIG. 4K are schematic diagrams illustrating manufacturing process of a single substrate liquid crystal display device in the third embodiment according to the present invention;

FIG. 5A to FIG. 5K are schematic diagrams illustrating manufacturing process of a single substrate liquid crystal display device in the fourth embodiment according to the present invention;

FIG. 6A to FIG. 6M are schematic diagrams illustrating manufacturing process of a liquid crystal display device without a substrate in the fifth embodiment according to the present invention; and

FIG. 7A to FIG. 7M are schematic diagrams illustrating manufacturing process of a liquid crystal display device without a substrate in the sixth embodiment according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A method for manufacturing liquid crystal display device is disclosed in the present invention. The present invention improves manufacturing process in prior art and provides alternatives for manufacturing liquid crystal display. Further, the present invention is applicable to manufacturing liquid crystal display without a substrate. By utilizing the manufacturing process, the purposes of increasing yield rate also providing a different method for manufacturing a LCD device are realized. Preferred embodiments of the present invention will be explained with reference to accompanying drawings.

FIG. 2A to FIG. 2N are schematic diagrams illustrating manufacturing process of a single substrate liquid crystal display device in the first embodiment according to the present invention. The manufacturing process comprises steps described as follows.

FIG. 2A to FIG. 2D illustrate process steps for forming a first substrate. In FIG. 2A, a buffer layer 51 is formed on a support substrate 50. In FIG. 2B, a photopolymer material layer 52 (such as photopolymer material NOA 65 or NOA 72) is coated on the buffer layer 51. In FIG. 2C, the photopolymer material layer 52 is exposed under ultra violate 5 and hardened to form a photopolymer material layer 52'. In FIG. 2D, an alignment layer 53 is coated on the photopolymer material layer 52' to form a first substrate 530.

FIG. 2E to FIG. 2J illustrate process steps for forming a second

substrate. In FIG. 2E, electrode pattern 540 is formed on a substrate 54. In FIG. 2F, an alignment layer 55 is coated on the substrate 54 and the electrode pattern 540. In FIG. 2G, a photopolymer material layer 56 is coated on the alignment layer 55. In FIG. 2H, an exposure process step is performed by a mask 57' radiating ultra violate 5'. In FIG. 2I, the photopolymer material layer 56 is hardened after mask exposure step and forms a polymer wall 56'. In FIG. 2J, cavities generated between the alignment layer 55 and the polymer wall 56' are filled with mixture 58 of liquid crystal and small amount of photopolymer by a dipping device 80. Accordingly, the second substrate 560 is formed.

FIG. 2K to FIG. 2N illustrate process steps for coupling the first substrate 530 and the second substrate 560. In the FIG. 2K, the first substrate 530 is position reversely on top of the second substrate 560. In FIG. 2K, the first substrate 530 is exposed under the mask 57 radiating ultra violate 5". In FIG. 2M, phase separation occurs between the photopolymer material and the liquid crystal in the mixture 58, and results in coupling of first substrate 530 and the second substrate 560. The polymer wall 56" is formed from the polymer wall 56' which can be used to couple with the upper substrate. At the same time, liquid crystal is separated from the photopolymer material, and the liquid crystal material 59 is wrapped by the polymer. In FIG. 2N, the support substrate 50 and

the buffer layer 51 are detached from the first substrate 530 and a single substrate liquid crystal display device is formed.

As the embodiment shown in the FIG. 2A to FIG. 2N, the first embodiment of the present invention forms a polymer wall 56" by solidifying photopolymer material with mask exposure. Such method does not reduce doping of polymer, also effectively increase the quality of liquid crystal formation and yield rate.

FIG. 3A to FIG. 3N are schematic diagrams illustrating manufacturing process of a liquid crystal display device in the second embodiment according to the present invention. The process steps of the second embodiment are largely identical with the steps of the first embodiment. The major difference lies in that the second embodiment utilizes molding along with ultra violate exposure for solidifying the polymer and forming a polymer wall with alignment on the second substrate. Polymer doping is effectively prevented by such method. The manufacturing process comprises steps described as follows.

FIG. 3A to FIG. 3D illustrate process steps for forming a first substrate 530. In FIG. 3A, a buffer layer 51 is formed on a support substrate 50. In FIG. 3B, a photopolymer material layer 52 (such as photopolymer material NOA 65 or NOA 72) is coated on the buffer layer 51. In FIG. 3C, the photopolymer material layer 52 is exposed under ultra violate 5 and hardened to form a photopolymer

material layer 52’. In FIG. 3D, an alignment layer 53 is coated on the photopolymer material layer 52’ to form a first substrate 530.

FIG. 3E to FIG. 3J illustrate process steps for forming a second substrate 560. In FIG. 3E, electrode pattern 540 is formed on a substrate 54. In FIG. 3F, a photopolymer material layer 56 is coated on the substrate 54 and the electrode pattern 540. In FIG. 3G, the polymer wall is shaped by molding the photopolymer material 56. In FIG. 3H, linear ultra violate”’ is used in an exposure step. In FIG. 3I, after the molding step and linear ultra violate exposure step, photopolymer material 56 is hardened to form a polymer wall 56”’ with alignment. In FIG. 3J, cavities generated between polymer walls 56”’ are filled with mixture 58 of liquid crystal and small amount of photopolymer by a dipping device 80. Accordingly, the second substrate 560 is formed.

FIG. 3K to FIG. 3N illustrate process steps for coupling the first substrate 530 and the second substrate 560. In the FIG. 3K, the first substrate 530 is position reversely on top of the second substrate 560. In FIG. 3L, the first substrate 530 is exposed under the mask 57 radiating ultra violate 5”. In FIG. 3M, after exposure step of ultra violate 5”, a phase separation occurs between liquid crystal and photopolymer material of the mixture 58. The photopolymer material is hardened and polymerized for coupling the first substrate 530 and the second substrate 560. A polymer

wall 56'''' is formed from the polymer wall 56'''in the FIG. 3L and part of the polymer wall 56''' coupled to the substrate 54. At the same time, the polymer is completely wrapped by the liquid crystal material 59. In FIG. 3N, the support substrate 50 and the buffer layer 51 are detached from the first substrate 530. Accordingly, a single substrate liquid crystal display in the second embodiment is completed. The difference between the first and the second embodiments is that: the first embodiment utilizes the mask exposure, whereas the second embodiment utilizes a molding method, which results in a more flexible manufacturing process, less polymer doping and better quality of liquid crystal.

FIG. 4A to FIG. 4K are schematic diagrams illustrating manufacturing process of a liquid crystal display device in the third embodiment according to the present invention. The process steps of the third embodiment are largely identical with the steps of the first embodiment. The major difference lies in the fact that electrodes are disposed in the first substrate, projections are disposed on the first and second substrates, and photopolymer material mixture is composed if photopolymer material, liquid crystal and spacers for providing a improved quality of manufacturing process of liquid crystal display. The manufacturing process comprises steps described as follows.

FIG. 4A to FIG. 4D illustrate process steps for forming a first

substrate 530'. In FIG. 4A, a buffer layer 51 is formed on a support substrate 50. In FIG. 4B, a photopolymer material layer 52 (such as photopolymer material NOA 65 or NOA 72) is coated on the buffer layer 51. In FIG. 4C, the photopolymer material layer 52 is exposed under ultra violate 5 and hardened to form a photopolymer material layer 52'. In FIG. 4D, electrodes 531 and projections 532 are formed on the polymer layer 52'. Further, an alignment layer 53 is formed on the photopolymer material layer 52'. Accordingly, a first substrate 530' is completed.

FIG. 4E to FIG. 4G illustrate process steps for forming a second substrate 560'. In FIG. 4E, electrode pattern 540 and projections 532" are formed on a substrate 54. In FIG. 4F, an alignment layer 55 is coated on the substrate 54, the electrode pattern 540 and projections 532". Further, a photopolymer material layer 56 is coated on the alignment layer 55. In the third embodiment of the present invention, as shown in the FIG. 4F, the polymer wall 56' is formed from hardening the photopolymer material layer 56 by mask exposure. On the other hand, the polymer wall formation in the third embodiment of present invention can also be completed by the molding method adapted in the second embodiment. In other words, the photopolymer material layer 56 is directly coated on the substrate 54, the electrode pattern 540 and projections 532'. Then the process moves to a molding

step and linear ultra violate exposure step for hardening photopolymer material 56 and forming the polymer wall with alignment as required (not shown in the diagram). In FIG. 4G, cavities generated between the alignment layer 55 and the polymer wall 56', where cavities can either be formed by mask exposure or aforementioned molding method, are filled with mixture 58 of liquid crystal and small amount of photopolymer. At the same time, spacers 561 are disposed. Accordingly, the second substrate 560' is formed.

FIG. 4H to FIG. 4K illustrate process steps for coupling the first substrate 530' and the second substrate 560'. In the FIG. 4H, the first substrate 530' is position reversely on top of the second substrate 560'. In FIG. 4I, the first substrate 530' is exposed under the mask 57 radiating ultra violate 5". In FIG. 4J, after exposure step of ultra violate 5", a phase separation occurs between liquid crystal and photopolymer material of the mixture 58', wherein the photopolymer material is hardened and polymerized to form liquid crystal 59, and coupling the first substrate 530' and the second substrate 560'. At the same time, the polymer is completely wrapped by the liquid crystal material 59. In FIG. 4K, the support substrate 50 and the buffer layer 51 are detached from the first substrate 530'. Accordingly, a single substrate and dual side electrode liquid crystal display device is completed, wherein

spacers 561 are disposed for effectively control the thickness of the liquid crystal layer, and the projections are disposed for effectively control the liquid crystal alignment modes. By employing such a method, different from the first and the second embodiments, viewing angle is improved also response rate of liquid crystal is increased.

FIG. 5A to FIG. 5K are schematic diagrams illustrating manufacturing process of a liquid crystal display device in the fourth embodiment according to the present invention. The manufacturing process is largely identical with the manufacturing process used in the third embodiment. The major difference lies in the fact that there are not any spacer disposed in the second substrate. However, the thickness of the liquid crystal layer is effectively controlled. The photopolymer material mixture is composed of photopolymer material and liquid crystal.

FIG. 5A to FIG. 5D illustrate process steps for forming a first substrate 530'. In FIG. 5A, a buffer layer 51 is formed on a support substrate 50. In FIG. 5B, a photopolymer material layer 52 (such as photopolymer material NOA 65 or NOA 72) is coated on the buffer layer 51. In FIG. 5C, the photopolymer material layer 52 is exposed under ultra violate 5 and hardened to form a photopolymer material layer 52'. In FIG. 5D, electrodes 531 and projections 532 are formed on the polymer layer 52'. Further, an alignment layer 53

is formed on the photopolymer material layer 52'. Accordingly, a first substrate 530' is completed.

FIG. 5E to FIG. 5G illustrate process steps for forming a second substrate 560". In FIG. 5E, electrode pattern 540 and projections 532" are formed on a substrate 54. In FIG. 5F, an alignment layer 55 is coated on the substrate 54, the electrode pattern 540 and projections 532". Further, a photopolymer material layer 56 is coated on the alignment layer 55. In the fourth embodiment of the present invention, as shown in the FIG. 5F, the polymer wall 56' is formed from hardening the photopolymer material layer 56 by mask exposure. On the other hand, the polymer wall formation in the fourth embodiment of present invention can also be completed by the molding method adapted in the second embodiment. In other words, the photopolymer material layer 56 is directly coated on the substrate 54, the electrode pattern 540 and projections 532'. Then the process moves to a molding step and linear ultra violate exposure step for hardening photopolymer material 56 and forming the polymer wall with alignment as required (not shown in the diagram). In FIG. 5G, cavities generated between the alignment layer 55 and the polymer wall 56', where cavities can either be formed by mask exposure or aforementioned molding method, are filled with mixture 58 of liquid crystal and small amount of photopolymer. Accordingly, the

second substrate 560" is formed.

FIG. 5H to FIG. 5K illustrate process steps for coupling the first substrate 530' and the second substrate 560". In the FIG. 5H, the first substrate 530' is position reversely on top of the second substrate 560". In FIG. 5I, the first substrate 530' is exposed under the mask 57 radiating ultra violate 5". In FIG. 5J, after exposure step of ultra violate 5", a phase separation occurs between liquid crystal and photopolymer material of the mixture 58, wherein the photopolymer material is hardened and polymerized to form liquid crystal 59, and coupling the first substrate 530' and the second substrate 560". At the same time, the polymer is completely wrapped by the liquid crystal material 59. In FIG. 5K, the support substrate 50 and the buffer layer 51 are detached from the first substrate 530'. Accordingly, a single substrate and dual side electrode liquid crystal display in the fourth embodiment is completed. The part different from the third embodiment shown in the FIG. 4 is that there are not any spacer disposed in the second substrate 560". In other words, the photopolymer material mixture is only composed of photopolymer material and liquid crystal and the composition does not include spacers. When implementing the fourth embodiment, an effective control over the thickness of liquid crystal layer is performed without disposing spacers.

FIG. 6A to FIG. 6I are schematic diagrams illustrating

manufacturing process of a liquid crystal display device in the fifth embodiment according to the present invention. The difference between the fifth embodiment and the third embodiment is that the fifth embodiment is implemented as a liquid crystal display device without a substrate. In FIG. 6A, a buffer layer 61 is formed on a first support substrate 60. The process then moves to a step of coating a photopolymer material layer 62 and a step of exposure radiation. In FIG. 6B, after the exposure of ultra violate 5 on the photopolymer material on the first support substrate 60, photopolymer material layer 62 is hardened to form polymer layer 62'. In FIG. 6C, electrodes 631 and projections 632 are formed on the polymer layer 62' of the first support substrate 60. In FIG. 6D, a alignment layer 63 is coated on the surface of the polymer layer 62' of the first support substrate 60, the electrodes 631 and the projections 632. Accordingly, the first substrate 630 is completed.

FIG. 6E illustrates the forming of the second substrate 660 in the fifth embodiment. A buffer layer 61 is formed on a second support substrate 70. The process then moves to a step of coating a photopolymer material layer 62 and a step of exposure radiation. In FIG. 6F, after the exposure of ultra violate 5 on the photopolymer material on the second support substrate 70, photopolymer material layer 62 is hardened to form polymer layer 62'. In FIG. 6G, electrodes 631 and projections 632 are formed on the polymer layer

62' of the second support substrate 70. In FIG. 6H, a alignment layer 63 is coated on the surface of the polymer layer 62' of the second support substrate 70, the electrodes 631 and the projections 632. At the same time, after an alignment layer 63 is coated on the polymer layer 62', the electrodes 631 and the projections 632 of the second support substrate 70. then a photopolymer material layer is coated on the substrate. Mask exposure is applied to the photopolymer material layer 66 to form a polymer wall 66'. A molding method for forming polymer wall can also be applied in the fifth embodiment of the present invention. A photopolymer material layer 66 is coated on the polymer layer 62', the electrodes 631 and the projections 632 of the second support substrate 70. Then the process moves to a molding step and linear ultra violate exposure step for hardening photopolymer material 66 and forming the polymer wall with alignment as required (not shown in the diagram). In FIG. 6I, cavities generated between the alignment layer 63 and the polymer wall 66', where cavities can either be formed by mask exposure or aforementioned molding method, are filled with mixture 68' of liquid crystal and small amount of photopolymer as well as spacers 661. Accordingly, the second substrate 660 is formed.

In FIG. 6J, after the first substrate 630 is positioned reversely on top of the second substrate 660, the process then moves to a

exposure step. In FIG. 6K, an exposure process step is performed by a mask 67 radiating ultra violate 5. In FIG. 6L, a phase separation occurs to the photopolymer material mixture 68' after exposure step. The photopolymer material is hardened and polymerized, liquid crystal layer 69 is formed, and the first substrate 630 and the second substrate 660' are coupled. At the same time, the polymer is completely wrapped by the liquid crystal material 69. In FIG. 6M, the support substrate 60 and the buffer layer 61 are detached from the first substrate 630. The support substrate 70 and the buffer layer 61 are detached from the second substrate 660. Accordingly, a dual side electrode liquid crystal display device without a substrate having spacers for controlling thickness of a liquid crystal layer is completed. By implementing fifth embodiment of the present invention, a liquid crystal display device without a substrate is realized. The fifth embodiment of the present invention can be widely applied to the manufacturing process of liquid crystal display device. Without a substrate, the liquid crystal display device can be easily attached to an object, such as attached to clothes, news papers, wind shield glass of cars, walls, books, and file folders. Such liquid crystal display device can be attached flexibly.

FIG. 7A to FIG. 7I are schematic diagrams illustrating manufacturing process of a liquid crystal display device in the sixth

embodiment according to the present invention. The sixth embodiment is also a manufacturing process of a liquid crystal display device without a substrate. The manufacturing process used is largely identical with the manufacturing process used in the fifth embodiment. The major difference lies in the fact that the photopolymer material mixture applied in the sixth embodiment does not include spacers.

In FIG. 7A, a buffer layer 61 is formed on a first support substrate 60. The process then moves to a step of coating a photopolymer material layer 62 and a step of exposure radiating ultra violate 5. In FIG. 7B, after the exposure of ultra violate 5 on the photopolymer material on the first support substrate 60, photopolymer material layer 62 is hardened to form polymer layer 62'. In FIG. 7C, electrodes 631 and projections 632 are formed on the polymer layer 62' of the first support substrate 60. In FIG. 7D, after an alignment layer 63 is coated on the polymer layer 62', the electrodes 631 and the projections 632 of the first support substrate 60. Accordingly, a first substrate 630 is completed.

In FIG. 7E, a step of forming a second substrate 660' is illustrated. A buffer layer 61 is formed on a second support substrate 70. The process then moves to a step of coating a photopolymer material layer 62 and a step of exposure radiating ultra violate 5. In FIG. 7F, after the exposure of ultra violate 5 on

the photopolymer material on the second support substrate 70, photopolymer material layer 62 is hardened to form polymer layer 62'. In FIG. 7G, electrodes 631 and projections 632 are formed on the polymer layer 62' of the second support substrate 70. In FIG. 7H, an alignment layer 63 is coated on the polymer layer 62', the electrodes 631 and the projections 632 of the second support substrate 70, then a photopolymer material layer 66 is coated on the substrate. Mask exposure is applied to the photopolymer material layer 66 to form a polymer wall 66'. On the other hand, alternatively, the polymer wall in the sixth embodiment can be formed by molding method. A photopolymer material layer 66 is coated on the polymer layer 62', the electrodes 631 and the projections 632 of the second support substrate 70. Then the process moves to a molding step and linear ultra violate exposure step for hardening photopolymer material 66 and forming the polymer wall with alignment as required by a mold (not shown in the diagram).

In FIG. 7I, cavities generated between the alignment layer 63 of the second support substrate 70 and the polymer wall 66', where cavities can either be formed by mask exposure or aforementioned molding method, are filled with mixture 68 of liquid crystal and small amount of photopolymer. Accordingly, the second substrate 660 is formed without disposing of spacers.

In the FIG 7J, the first substrate and the second substrate are coupled. Firstly, the first substrate 630 is positioned reversely on top of the second substrate 660', the process then moves to an exposure step. In FIG. 7K, an exposure process step is performed by a mask 67 radiating ultra violate 5. In FIG. 7L, an phase separation occurs to the photopolymer material mixture 68 after exposure step. The photopolymer material is hardened and polymerized, liquid crystal layer 69 is formed, and the first substrate 630 and the second substrate 660' are coupled. At the same time, the polymer is completely wrapped by the liquid crystal material 69. In FIG. 7M, the support substrate 60 and the buffer layer 61 are detached from the first substrate 630. The support substrate 70 and the buffer layer 61 are detached from the second substrate 660'. Accordingly, a single substrate and dual side electrode liquid crystal display is completed without disposing spacers and substrate. Without a substrate, the liquid crystal display device can be easily attached to an object, such as attached to clothes, news papers, wind shield glass of cars, walls, books, and file folders. Such liquid crystal display device can be attached flexibly. In the embodiments described above, the photopolymer material can be photocurable resin. The polymer wall formed by photopolymer material is a closed matrix polymer wall or a non-closed matrix polymer wall. Further more, the material of the support substrate and the substrate of the second substrate can be

glass, chipsets, teflon or plastic. The material of the electrode pattern of the first or the second substrate is conducting film made of ITO or PEDOT (polyethylene-dioxithiophene). The material of the buffer layer can be PE/PEWax, long chain aliphatics, silicone, or teflon. The alignment layer manufacturing process step is performed by rubbing alignment, photo alignment, ion beam alignment or micro texture structure alignment. The micro texture structure alignment is performed by molding a special designed mold pattern, so as to form the polymer wall and the micro texture structure alignment. The alignment material used in the aforementioned alignment manufacturing process step can be polyimide, polyamic acid or a photo alignment material.

On the other hand, projections mentioned from the third to the sixth embodiments are made of organic materials, which increase the range of viewing angle, wherein the projections are formed by molding a special designed mold pattern, so as to generate a wide viewing angle of multi domain and increase the viewing quality of the liquid crystal display device.

Further more, the liquid crystal used in the embodiments above can be nematic, cholesteric, ferroelectric, or anti-ferroelectric liquid crystal. The dopant used in the liquid crystal material includes be dye, chiral molecule and monomer. By utilizing the liquid crystal materials and dopant used as mentioned above, resulting display

modes comprise transmissive mode, reflective mode, and half-transmissive half reflective mode. The operation modes include in plane switching mode and non coplanar switching mode. All embodiments mentioned above utilized a roll to roll manufacturing process. The count of electrodes and projections can be an even number or an odd number.

A detailed description of the manufacturing process for a liquid crystal display device according to the present invention is disclosed above. The manufacturing process according to the present invention can resolve the problems occurred to the prior art technology proposed by KONINKL PHILIPS ELECTRONICS NV such as the second exposure involving with a step using low energy and long process time, possible deterioration of liquid crystal, small manufacturing window, low yield rate, and limited display modes applicable. In other words, the present invention provide a manufacturing process not only increases yield rate, diversified display modes, improved method for wrapping liquid crystal molecules and a improved control over the thickness of a liquid crystal layer.

Although the invention is illustrated and described herein with reference to particular embodiments, the invention is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of

equivalents of the claims and without departing from the spirit of the invention.